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ABSTRACT

This study examines at the elementary school level four different types of instruments in order to assess their capability to measure the attitudes toward arithmetic of third and fifth grade children. The four arithmetic attitude instruments were administered using a Latin Square model and included: the Dutton-Thurstone Scale, the Dutton-Likert Scale, a Guttman-type Hoyt Scale, and a version of the Semantic Differential measuring the concept "Arithmetic and Me." The intercorrelations among the scales yielded correlations significant at the .01 level, in all cases, across grade and sex. The multiple regression analysis to predict teacher arithmetic grade indicated that I.Q. is the best predictor for both grades and sexes; however, the addition of arithmetic attitude scale scores did contribute positively to the prediction of teacher grade with the Hoyt Scale contributing the most. The regression analysis to predict Iowa Arithmetic Total inferred that I.Q. was the single best predictor. Again, the addition of arithmetic attitude scale scores contributed positively to the prediction with the Dutton-Likert being the most significant predictor in all cases except girls, grade five, where the Hoyt contributed most to the multiple correlations. (Author/DG)

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AN EXAMINATION

OF

FOUR ARITHMETIC ATTITUDE SCALES

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The importance of a student's attitude toward arithmetic has recently been highlighted in a review by Aiken, 1969. In addition, researchers in the area of school related attitude generally have hypothesized that an individual's attitude toward a subject, as arithmetic, affects what he learns, what he remembers, and what he does, i.e., a pupil's attitude appears to act as a catalyst which contributes to the efficient utilization of his abilities and experiences in learning that subject (Bassham, Murphy, and Murphy, 1964; Mager, 1968). However, research by Neale (1969, 1970) has indicated that the contribution of arithmetic attitude in the prediction of arithmetic achievement is minimal and explains little of the variation in student's performance in arithmetic. It seems essential, therefore, that educators be given empirical data to clarify the role of arithmetic attitude in the prediction of arithmetic achievement.

A survey of the arithmetic attitude literature (Aiken 1969) reveals the existence of a number of arithmetic attitude scales which have been used in empirical research. It seems essential, then, that an attempt be made to examine in a single study some of the various instruments that have been used to assess a pupil's attitude toward arithmetic. It is clearly evident that the work of Dutton has led to the most widely used arithmetic attitude instrument, a Thurstone-type scale of 15 items. This scale has been employed at the elementary and junior high level with both teachers and students, Dutton (1951, 1956, 1962, 1968) Bassham, Murphy, and Murphy (1964). More recently, Dutton in conjunction with Blum (1968), has developed a 25-item Likert-type scale to assess students' feelings toward arithmetic. Since this scale was developed rather recently, it must be examined empirically, as Dutton has suggested. (Dutton & Blum, 1968).

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Another approach, different in terms of scaling method to the measurement of arithmetic attitude, is a Guttman-type scale of 94 items developed by Hoyt (1960). Recent work by Anttonen (1967) has modified the scale to 28 items and it has been used in studies by Deighan (1970) and Mastantuono (1970). A more disguised technique utilized to measure attitudes in general and advocated by Neale (1970), is the semantic differential developed by Osgood, Tannebaum and Succi (1957). This instrument has been employed in studies in arithmetic attitude by Anttonen (1967) Deighan (1970), and Mastantuono (1970).

Since a review of the literature reveals the four attitude scales depicted above to be some of the more widely used attitude scales as well

as representing four fundamentally different scaling techniques, an attempt should be made to examine all four techniques in a single study. Thus, the purpose of the present research was twofold: 1) to investigate the inter-relationships of four arithmetic attitude scales, and 2) to examine the predictive ability of arithmetic attitude in the prediction of arithmetic achievement.

More specifically, a total of 602 third and fifth grade students in a suburban district of a large metropolitan area were administered over a two-day period the four arithmetic attitude instruments in April, 1970. In order to guard against order effect, a Latin Square model was used in administering the tests. In addition, the study included as measures of arithmetic achievement the Iowa Tests of Basic Skills (Arithmetic Sub-Test Total only) and teacher arithmetic grade (third marking period-April). The total Iowa achievement battery was administered as part of the school system's regular group test program in March, 1970. Since previous research (Hungerman, 1965; Neale and Proshek, 1967) has shown that intelligence was the best predictor of arithmetic achievement, the Lorge-Thorndike Intelligence Tests (Total, only) was used as a measure of intelligence at grade three and the California Test of Mental Maturity (Total, only) was used as a measure of intelligence at grade five. Both tests were also administered by the participating school district as part of their March group test program.

In order to examine the predictors of arithmetic achievement, as measured by both Iowa Arithmetic Achievement (Total) and teacher arithmetic grade, two multiple regression analyses were performed for each grade by sex split separately. In both analyses the arithmetic achievement measure served as the dependent variable while the intelligence score and the four arithmetic attitude scale scores served as the independent variables. It should be noted that there were possible difficulties in the regression data analyses: 1) the supposed common trait measurement involved in the four attitude scales could make the independent variables highly correlated, and 2) the restricted range, i.e., A to E or 5 to 1, for the teacher arithmetic grade could reduce the magnitude of the correlations.

In Tables 1-8 are presented the intercorrelations of all dependent and independent variables for each grade by sex split. As can be seen from Tables 1-8, all four attitude scales intercorrelate significantly with the correlations ranging from .560 ($p < .01$) for the Dutton-Thurstone and the Semantic Differential to .821 ($p < .01$) for the Hoyt Scale and the Semantic Differential across grade level and sex. Furthermore, Tables 1-4 reveal that the IQ measures correlate the highest of all predictors with the Iowa Arithmetic Total with correlations ranging from .649 ($p < .01$) for the California Test of Mental Maturity (Total) to .756 ($p < .01$) for the Lorge-Thorndike Intelligence Tests (Total). The correlations of the attitude scales and the Iowa Arithmetic Total are lower than the intelligence-achievement correlations ranging from a low of .025 for the Dutton-Thurstone to a high of .367 ($p < .01$) for the Dutton-Likert.

As can be seen from Tables 5-8, results similar to the above were obtained when the teacher grade was used as a measure of arithmetic achievement. Again, the IQ-achievement correlations which ranged from .414 ($p < .01$) for the California Test (Total) to .571 ($p < .01$) for the Lorge-Thorndike Tests (Total) were higher than the attitude-achievement correlations which ranged from .051 for the Dutton-Thurstone to .350 ($p < .01$) for the Hoyt Scale.

The above intercorrelations served as the basis for the regression analyses which were performed for the two arithmetic achievement dependent measures for each of the grades by sex divisions. The results of these regression analyses are summarized in Tables 9-16. As Tables 9-12 show, IQ is the single best predictor of Iowa Arithmetic Total for all grade by sex splits with the Dutton-Likert scale adding significantly to the multiple correlation for boys at grades three and five and for girls at grade three. For girls at grade five, the Hoyt Scale added significantly to the multiple correlation.

As Tables 13 to 16 indicate, for all grade by sex splits, I.Q. again is the best predictor of arithmetic achievement as measured by teacher grade. Furthermore, for each grade by sex split, the Hoyt Scale contributes significantly to the multiple correlations.

Thus, the present study suggests that the four arithmetic attitude scales, the Dutton-Thurstone, the Dutton-Blum Likert, the Hoyt-Guttman and the Semantic Differential, are significantly interrelated. Generally, the results of the regression analyses indicate that there is a positive relationship, although small, between a student's arithmetic attitude and his behavioral tendencies (as measured by achievement) in arithmetic. That is, the results of the study indicate that both the Dutton-Likert Scale scores and the Hoyt Scale scores did contribute significantly to the prediction of arithmetic achievement. The former contributed the greatest in predicting Iowa Arithmetic (Total) while the latter contributed the greatest in predicting teacher arithmetic grade. It would seem, then, that Neale's (1969, 1970) contention (i.e., the contribution of measured arithmetic attitude is minimal when utilized in predicting arithmetic achievement) received little support from the findings of this investigation. However, this study does support the results of previous research studies which have shown that I.Q. correlates highly with arithmetic achievement and is the best predictor. Clearly the teacher grade and student attitude relationship (as measured by the Hoyt Scale) as well as the work of Anttonen (1967), Deighan (1970), and Neale (1970), indicating a decline in student arithmetic attitudes as they progress in the elementary grades, highlight the importance for the teacher of conditioning more favorable attitudes toward arithmetic in her students.

In order to create these more favorable attitudes toward arithmetic in her students, elementary school teachers could perhaps look into individualized instruction, computer-assisted instruction, and arithmetic games. Obviously, the role that mathematics play in our complex society

mandates that students do not become discouraged with arithmetic in the elementary grades and therefore elect fewer courses in mathematics at the high school level. As Bradford (1970) indicates, this would be an educational waste both for the individual and society.

TABLE 1

INTERCORRELATIONS AMONG SELECTED PREDICTOR VARIABLES AND IOWA ARITHMETIC (TOTAL) ACHIEVEMENT FOR BOYS, GRADE 3
(N = 157)

	Iowa Arithmetic Total	Dutton-Thurstone	Dutton-Likert	Hoyt Scale	Semantic Differential	I.Q. (Lorge Thorndike Total)
Iowa Arithmetic Total	1.000					
Dutton-Thurstone	.135	1.000				
Dutton-Likert	.367**	.620**	1.000			
Hoyt Scale	.227**	.715**	.675**	1.000		
Semantic Differential	.264**	.560**	.708**	.766**	1.000	
I.Q. (Lorge Thorndike Total)	.679**	.034	.206**	.105	.142	1.000

*p <.05

**p <.01

TABLE 2

INTERCORRELATIONS AMONG SELECTED PREDICTOR VARIABLES AND IOWA ARITHMETIC (TOTAL) ACHIEVEMENT FOR GIRLS, GRADE 3
(N = 134)

	Iowa Arithmetic Total	Dutton-Thurstone	Dutton-Likert	Hoyt Scale	Semantic Differential	I.Q. (Lorge Thorndike Total)
Iowa Arithmetic Total	1.000					
Dutton-Thurstone	.034	1.000				
Dutton-Likert	.213*	.683**	1.000			
Hoyt Scale	.213*	.747**	.739**	1.000		
Semantic Differential	.086	.713**	.759**	.821**	1.000	
I.Q. (Lorge Thorndike Total)	.756**	-.022	.167	.169*	.021	1.000

*$p < .05$

**$p < .01$

TABLE 3

INTERCORRELATIONS AMONG SELECTED PREDICTOR VARIABLES AND IOWA ARITHMETIC (TOTAL) ACHIEVEMENT FOR BOYS, GRADE 5
(N = 167)

	Iowa Arithmetic Total	Dutton-Thurstone	Dutton-Likert	Hoyt Scale	Semantic Differential	I.Q. (California Total)
Iowa Arithmetic Total	1.000					
Dutton-Thurstone	.025	1.000				
Dutton-Likert	.282**	.710**	1.000			
Hoyt Scale	.150*	.778**	.773**	1.000		
Semantic Differential	.136	.732**	.790**	.790**	1.000	
I.Q. (California Total)	.682**	-.065	.121	.013	.016	1.000

*$p \leq .05$

**$p \leq .01$

TABLE 4

INTERCORRELATIONS AMONG SELECTED PREDICTOR VARIABLES AND IOWA ARITHMETIC (TOTAL) ACHIEVEMENT FOR GIRLS, GRADE 5
(N = 144)

	Iowa Arithmetic Total	Dutton-Thurstone	Dutton-Likert	Hoyt Scale	Semantic Differential	I.Q. (California Total)
Iowa Arithmetic Total	1.000					
Dutton-Thurstone	.099	1.000				
Dutton-Likert	.137	.636**	1.000			
Hoyt Scale	.228**	.654**	.750**	1.000		
Semantic Differential	.144	.638**	.740**	.782**	1.000	
I.Q. (California Total)	.649**	-.068	.056	.026	.025	1.000

*p <.05

**p <.01

TABLE 5

INTERCORRELATIONS AMONG SELECTED PREDICTOR VARIABLES AND THIRD MARKING PERIOD TEACHER ARITHMETIC GRADE FOR BOYS, GRADE 3
(N = 157)

	Class Grade	Dutton-Thurstone	Dutton-Likert	Hoyt Scale	Semantic Differential	I.Q. (Lorge Thorndike Total)
Class Grade	1.000					
Dutton-Thurstone	.073	1.000				
Dutton-Likert	.281**	.620**	1.000			
Hoyt Scale	.231**	.715**	.675**	1.000		
Semantic Differential	.233**	.560**	.708**	.766**	1.000	
I.Q. (Lorge-Thorndike, Total)	.468**	.034	.205*	.105	.142	1.000

*p ≤ .05

**p ≤ .01

TABLE 6

INTERCORRELATIONS AMONG SELECTED PREDICTOR VARIABLES AND THIRD MARKING PERIOD TEACHER ARITHMETIC GRADE FOR GIRLS, GRADE 3
(N = 134)

	Class Grade	Dutton-Thurstone	Dutton-Likert	Hoyt Scale	Semantic Differential	I.Q. (Lorge Thorndike Total)
Class Grade	1.000					
Dutton-Thurstone	.219*	1.000				
Dutton-Likert	.319**	.683**	1.000			
Hoyt Scale	.350**	.747**	.739**	1.000		
Semantic Differential	.180*	.713**	.760**	.821**	1.000	
I.Q. (Lorge Thorndike Total)	.571**	.022	.167	.169	.021	1.000

* $p \leq .05$

** $p \leq .01$

TABLE 7

INTERCORRELATIONS AMONG SELECTED PREDICTOR VARIABLES AND THIRD MARKING PERIOD TEACHER ARITHMETIC GRADE FOR BOYS, GRADE 5
(N = 167)

	Class Grade	Dutton-Thurstone	Dutton-Likert	Hoyt Scale	Semantic Differential	I.Q. (California Total)
Class Grade	1.000					
Dutton-Thurstone	.150*	1.000				
Dutton-Likert	.184*	.710**	1.000			
Hoyt Scale	.292**	.778**	.734**	1.000		
Semantic Differential	.216**	.732**	.790**	.790**	1.000	
I.Q. (California Total)	.511**	.065	.121	.013	.016	1.000

*$p < .05$

**$p < .01$

TABLE 8

INTERCORRELATIONS AMONG SELECTED PREDICTOR VARIABLES AND THIRD MARKING PERIOD TEACHER ARITHMETIC GRADE FOR GIRLS, GRADE 5
(N = 144)

	Class Grade	Dutton-Thurstone	Dutton-Likert	Hoyt Scale	Semantic Differential	I.Q. (California Total)
Class Grade	1.000					
Dutton-Thurstone	.051	1.000				
Dutton-Likert	.221**	.636**	1.000			
Hoyt Scale	.341**	.654**	.749**	1.000		
Semantic Differential	.170*	.638**	.740**	.782**	1.000	
I.Q. (California Total)	.414**	.068	.056	.026	.025	1.000

*p <.05

**p <.01

TABLE 9

MULTIPLE CORRELATIONS OF DEPENDENT VARIABLE ICMA ARITHMETIC (TOTAL) ACHIEVEMENT AND SELECTED INDEPENDENT VARIABLES FOR BOYS, GRADE 3
(N = 157)

Independent Variable Numbers	Multiple R^2
7,4,3,5,6	.517**
7,4,3,5	.517**
7,4,3	.517**
7,4	.515**
7	.461**

**p<.01

3 Dutton-Thurstone
4 Dutton-Likert
5 Hoyt Scale
6 Semantic Differential
7 I.Q. (Lorge-Thorndike Total)

TABLE 10

MULTIPLE CORRELATIONS OF DEPENDENT VARIABLE IOWA ARITHMETIC (TOTAL) ACHIEVEMENT AND SELECTED INDEPENDENT VARIABLES FOR GIRLS, GRADE 3
(N = 134)

Independent Variable Numbers	Multiple R^2
7,4,5,3,6	.582**
7,4,5,3	.582**
7,4,5	.580**
7,4	.579**
7	.572**

**p≤.01

3 Dutton-Thurstone
4 Dutton-Likert
5 Hoyt Scale
6 Semantic Differential
7 I.Q. (Lorge-Thorndike Total)

TABLE 11

MULTIPLE CORRELATIONS OF DEPENDENT VARIABLE IOWA ARITHMETIC (TOTAL) ACHIEVEMENT AND SELECTED INDEPENDENT VARIABLES FOR BOYS, GRADE 5
(N = 167)

Independent Variable Numbers	Multiple R^2
7,4,3,5,6	.522**
7,4,3,5	.520**
7,4,3	.517**
7,4	.505**
7	.465**

**p<.01

3 Dutton-Thurstone
4 Dutton-Likert
5 Hoyt Scale
6 Semantic Differential
7 I.Q. (California Total)

TABLE 12

MULTIPLE CORRELATIONS OF DEPENDENT VARIABLE IOWA ARITHMETIC (TOTAL) ACHIEVEMENT AND SELECTED INDEPENDENT VARIABLES FOR GIRLS, GRADE 5 (N = 144)

Independent Variable Numbers	Multiple R^2
7,5,4,3,6	.477**
7,5,4,3	.475**
7,5,4	.474**
7,5	.466**
7	.422**

**p < .01

3 Dutton-Thurstone
4 Dutton-Likert
5 Hoyt Scale
6 Semantic Differential
7 I.Q. (California Total)

TABLE 13

MULTIPLE CORRELATIONS OF DEPENDENT VARIABLE THIRD MARKING PERIOD TEACHER ARITHMETIC GRADE AND SELECTED INDEPENDENT VARIABLES FOR BOYS, GRADE 3 (N = 157)

Independent Variable Numbers	Multiple R^2
7,4,3,5,6	.279*
7,4,3,5	.279**
7,3,5	.264**
7,5	.253**
7	.219**

*p <.05

**p <.01

3 Dutton-Thurstone
4 Dutton-Likert
5 Hoyt Scale
6 Semantic Differential
7 I.Q. (Lorge Thorndike Total)

TABLE 14

MULTIPLE CORRELATIONS OF DEPENDENT VARIABLE THIRD MARKING PERIOD TEACHER ARITHMETIC GRADE AND SELECTED INDEPENDENT VARIABLES FOR GIRLS, GRADE 3 (N = 134)

Independent Variable Numbers	Multiple R^2
7,5,6,4,3	.412**
7,5,6,4	.410**
7,5,6	.400**
7,5	.393**
7	.327**

*p ≤ .05

**p ≤ .01

3 Dutton-Thurstone
4 Dutton-Likert
5 Hoyt Scale
6 Semantic Differential
7 I.Q. (Lorge Thorndike Total)

TABLE 15

MULTIPLE CORRELATIONS OF DEPENDENT VARIABLE THIRD MARKING PERIOD TEACHER ARITHMETIC GRADE AND SELECTED INDEPENDENT VARIABLES FOR BOYS, GRADE 5 (N = 167)

Independent Variable Numbers	Multiple R^2
7,5,4,6,3	.363**
7,5,4,6	.362**
7,5,4	.360**
7,5	.343**
7	.262**

*p<.05

**p<.01

3 Dutton-Thurstone
4 Dutton-Likert
5 Hoyt Scale
6 Semantic Differential
7 I.Q. (California Total)

TABLE 16

MULTIPLE CORRELATIONS OF DEPENDENT VARIABLE THIRD MARKING PERIOD TEACHER ARITHMETIC GRADE AND SELECTED INDEPENDENT VARIABLES FOR GIRLS, GRADE 5 (N = 144)

Independent Variable Numbers	Multiple R^2
7,5,3,6,4	.326**
7,5,3,6	.326**
7,5,3	.313**
7,5	.280**
5	.171*

*p<.05

**p<.01

3 Dutton-Thurstone
4 Dutton-Likert
5 Hoyt Scale
6 Semantic Differential
7 I.Q. (California Total)

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